

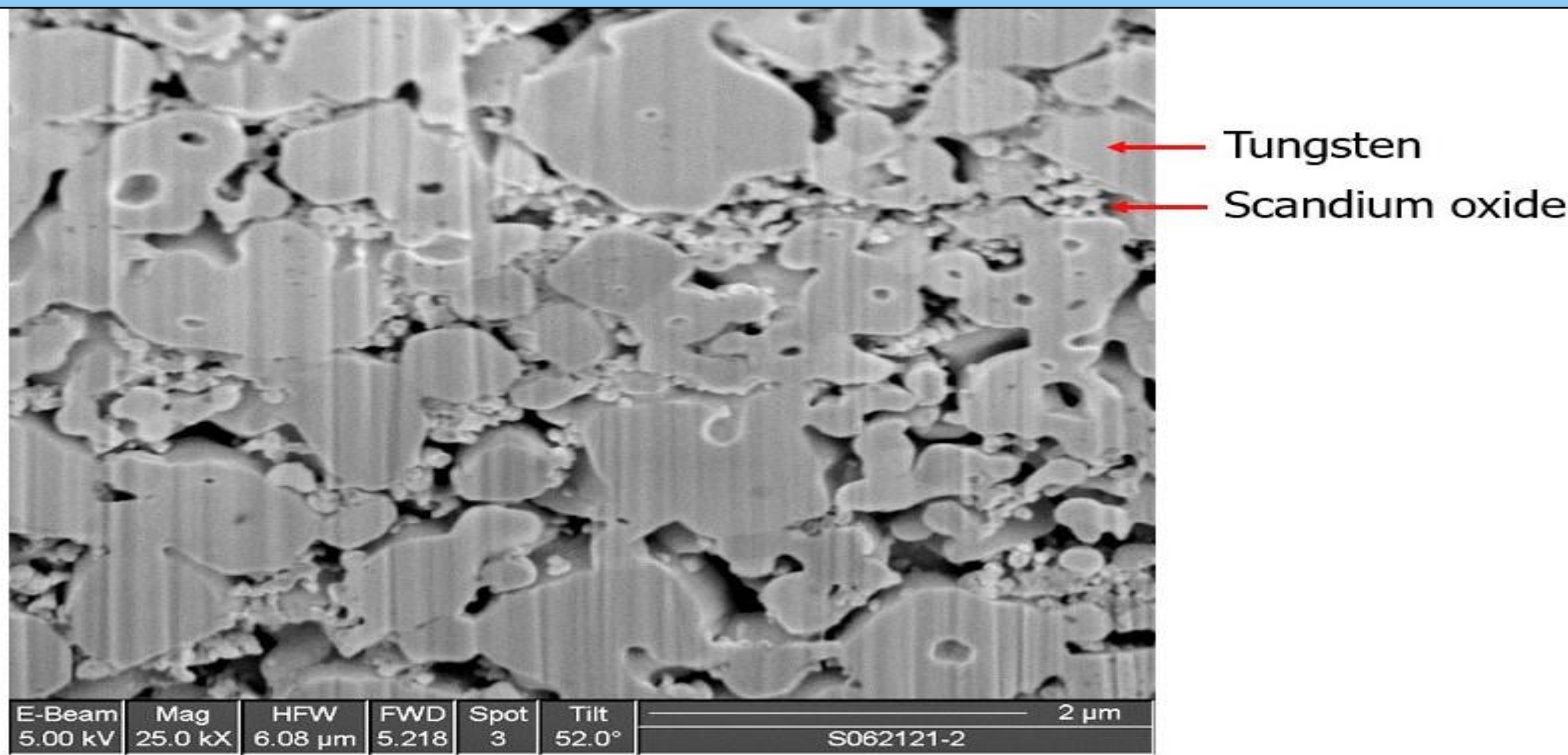
Evidence for semiconducting Behavior of Scandate Cathodes

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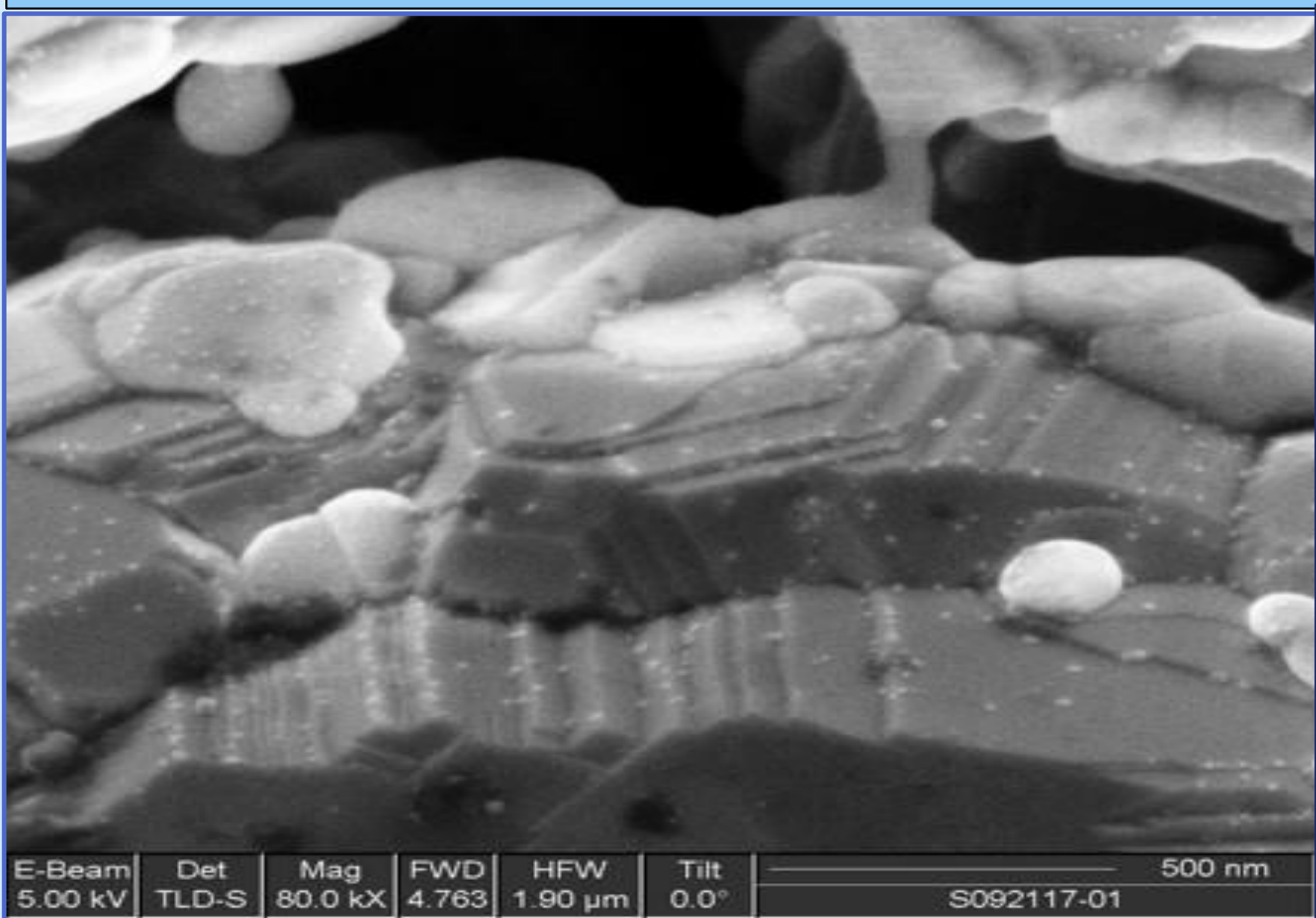
- **Scandate Cathodes (nano scandia doped tungsten)** provide record-breaking emission at fixed temperature.
 - Many theories of emission
 - Conventional understanding - 80 nm scandium rich semiconductor coating on emission surface [3,4]
 - We don't see 80 nm layer on our cathodes, more like 8-10 nm on all tungsten particles..
- Experimental data reviewed
- New model presented

[4] Y. Wang, J. Wang, et. al., "Correlation between emission behavior and surface features of scandate cathodes.", IEEE Trans. Electron Devices, vol. 56, no. 5, pp. 776-785, May 2009.

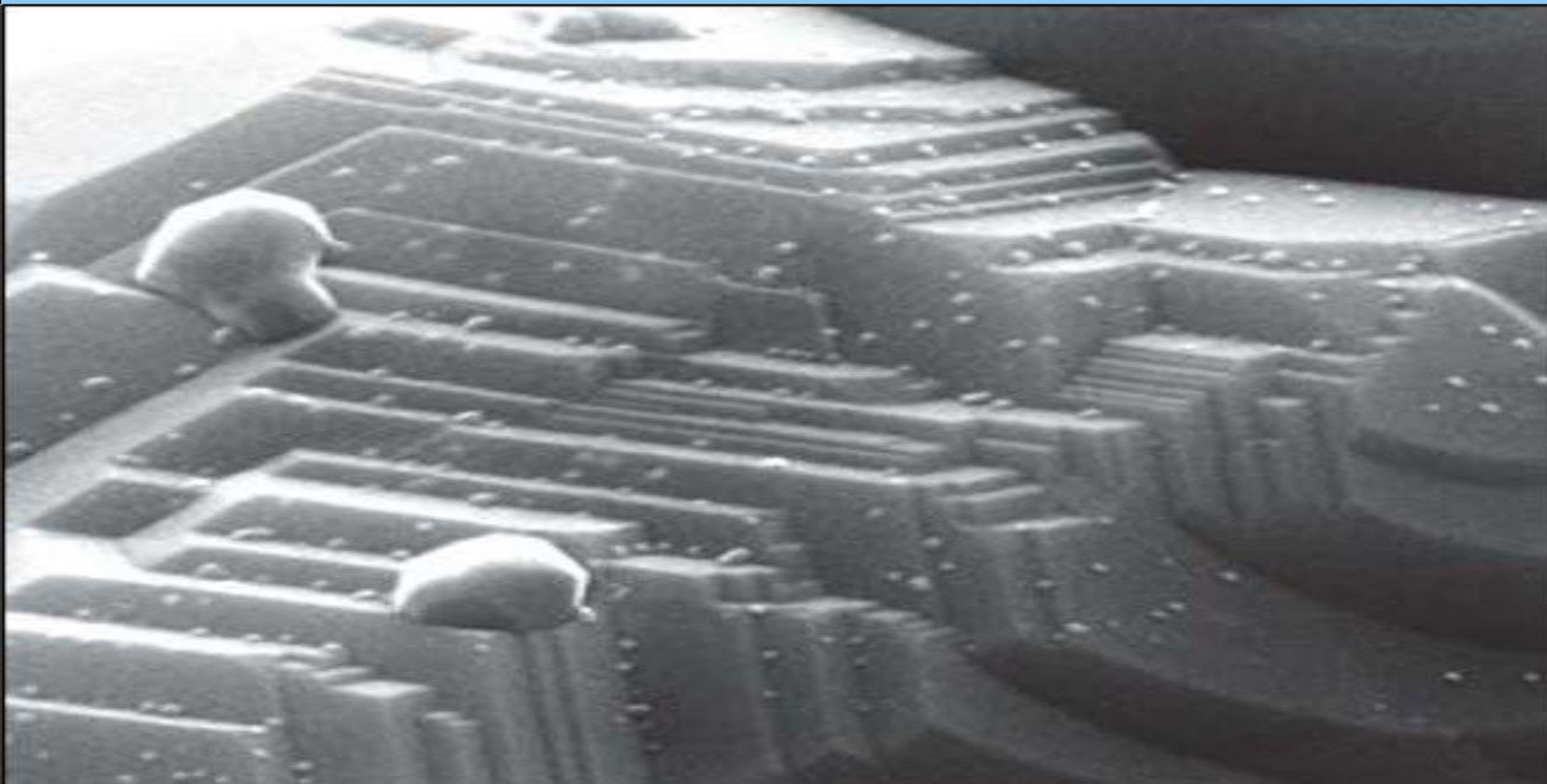
SEM of Sintered Matrix Cross-section



Cathode Surface, Activated Cathode, e beam



Cathode Surface, BJUT



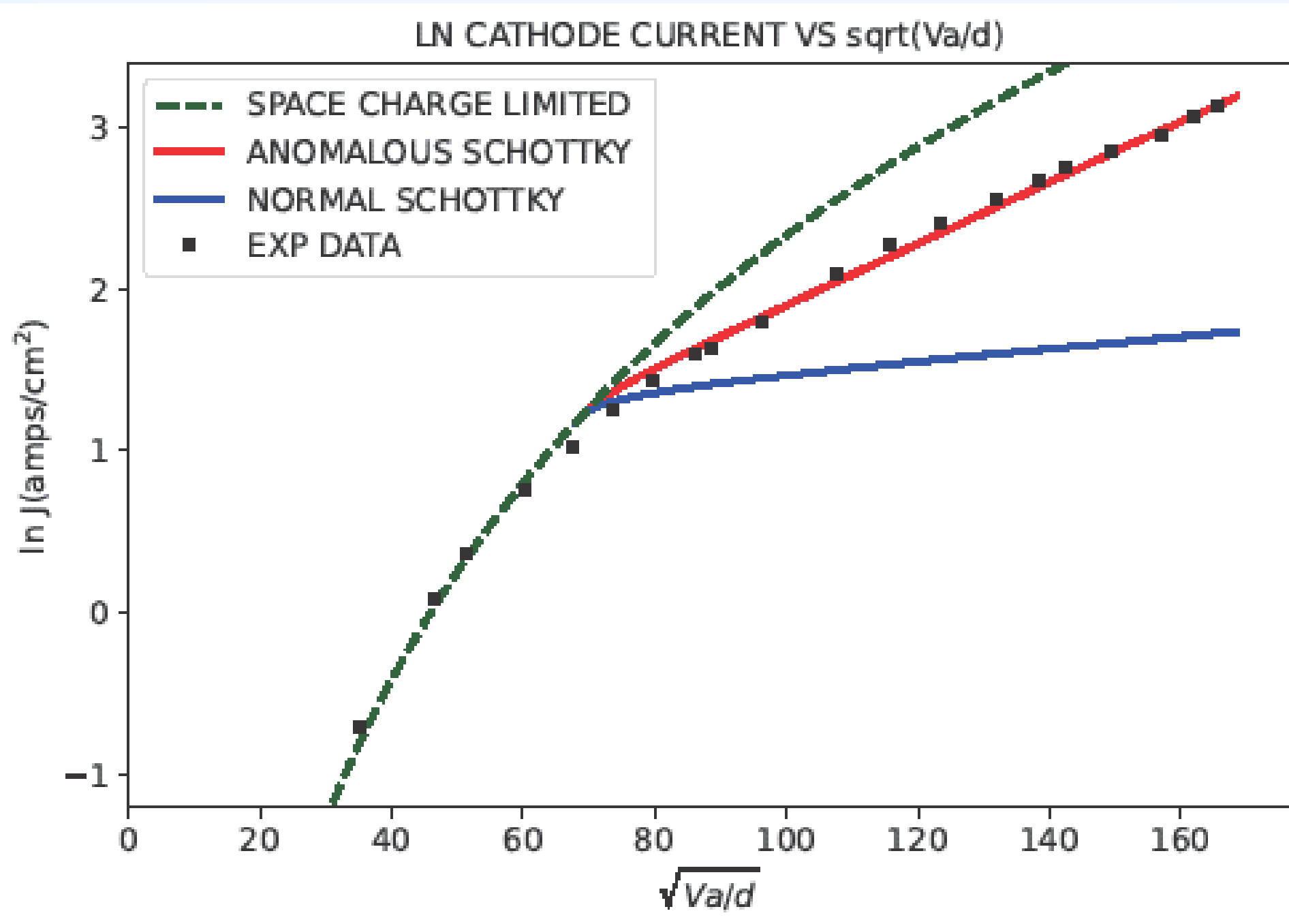
Evidence of Semiconductor

- Anomalous Schottky Effect
- Low Work Function
- Extraordinary performance in inert gas discharge >60 A/cm²
- Auger data
- TEM data
- Needs current draw during activation

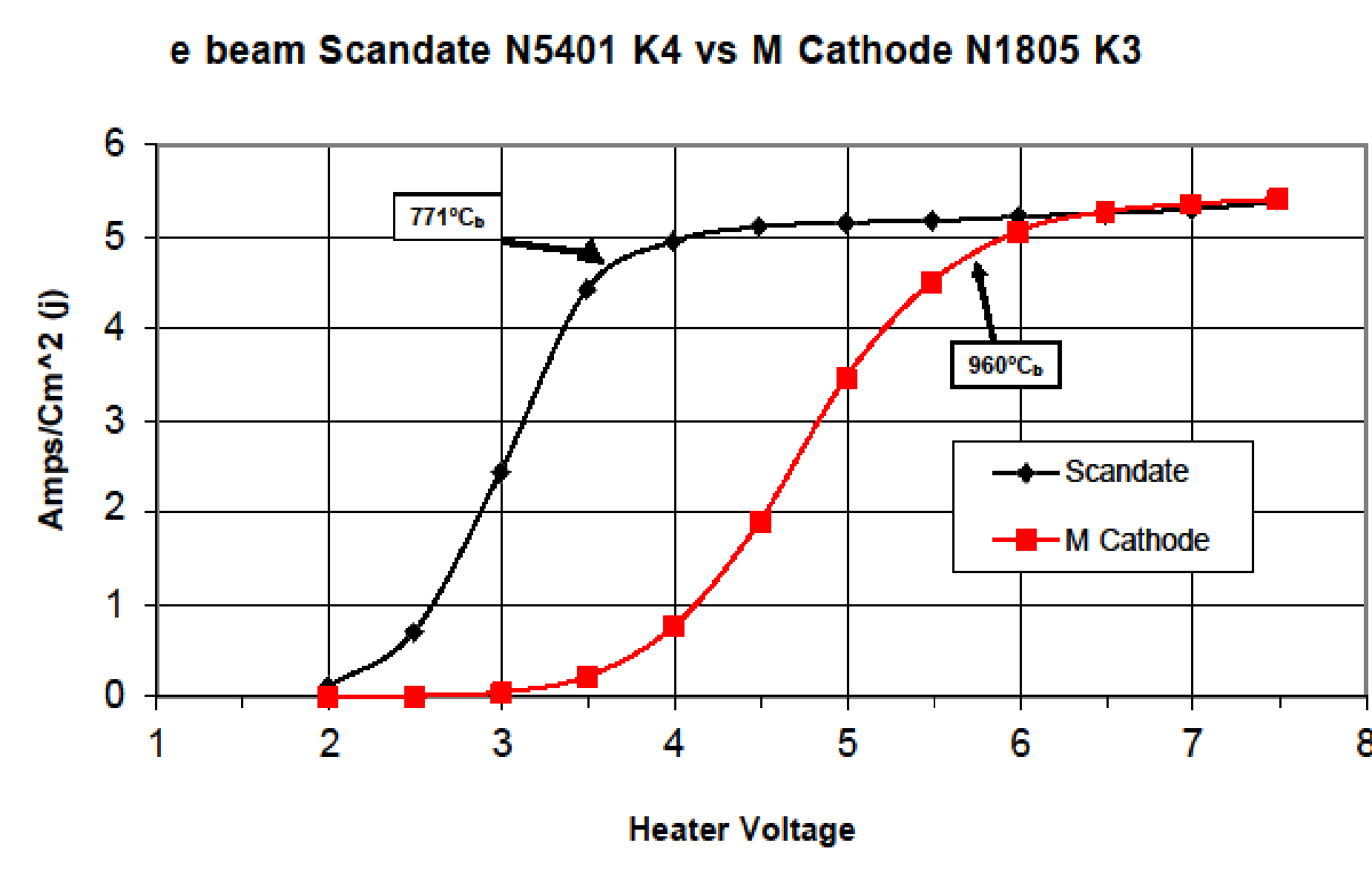
Evidence of Metal Cathodes

- Duty insensitive
- SEM surface photos – peculiar morphology

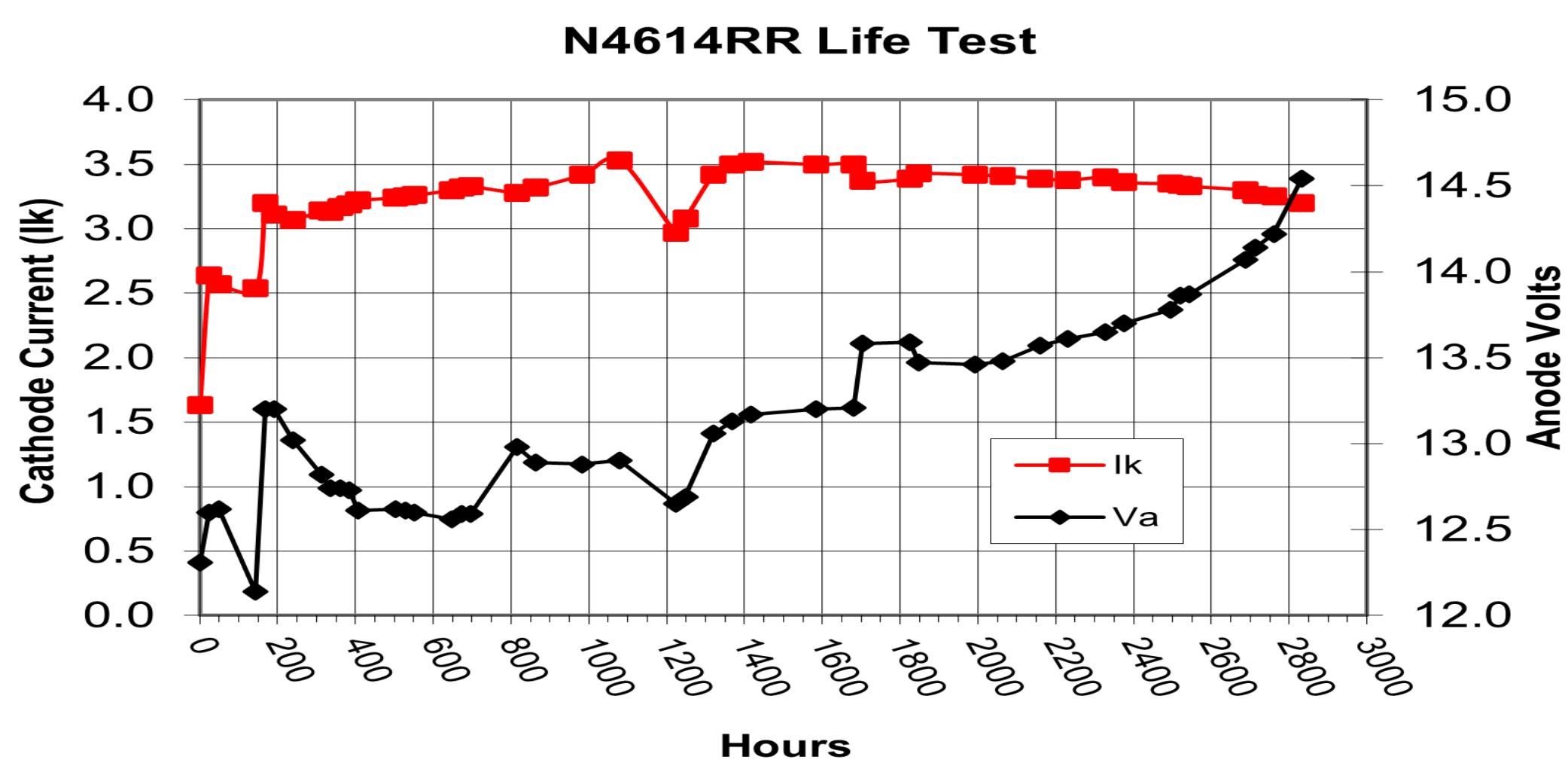
Schottky Plot N5401K1



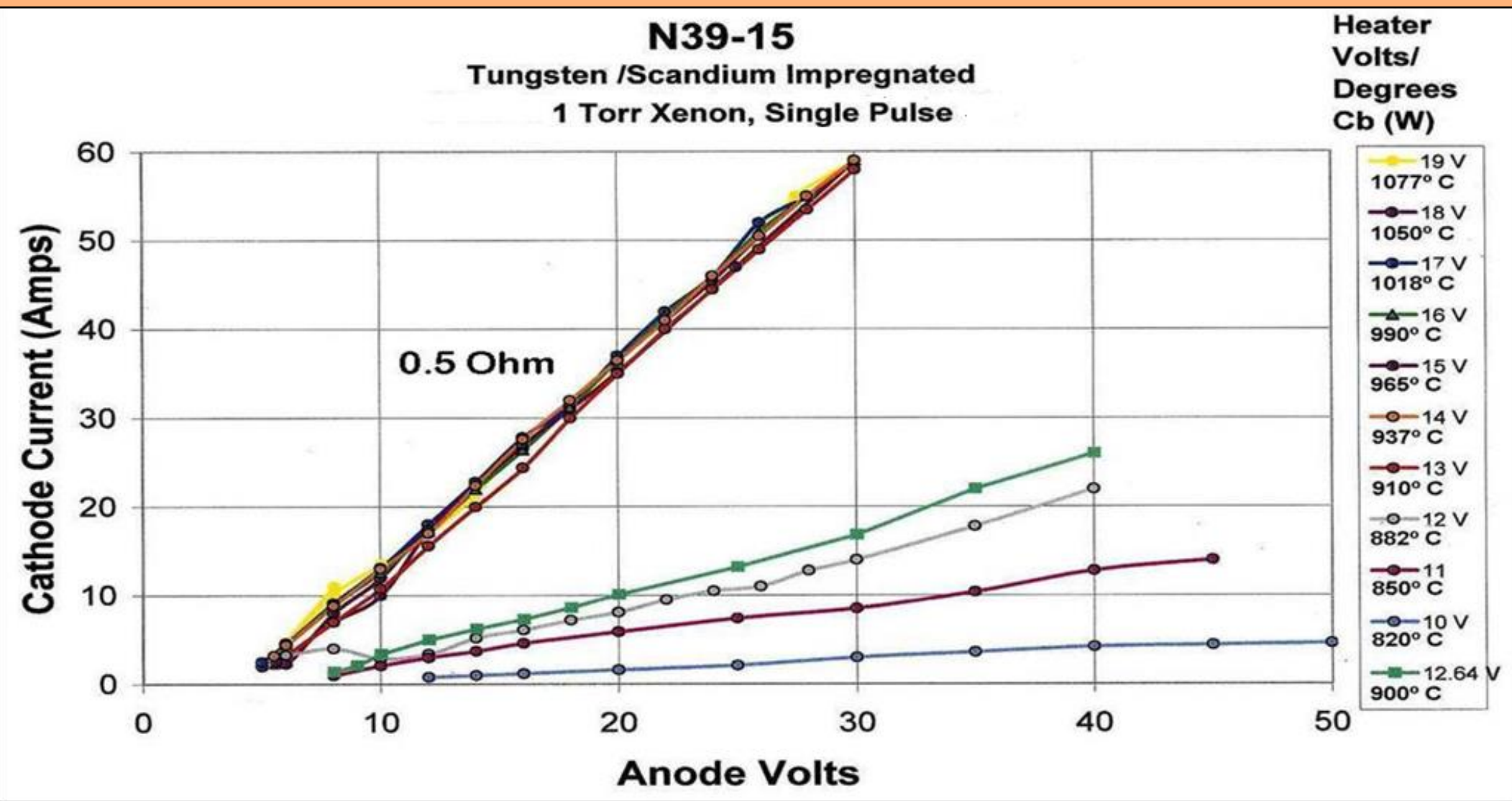
Activity Comparison - Scandate & M Cathode



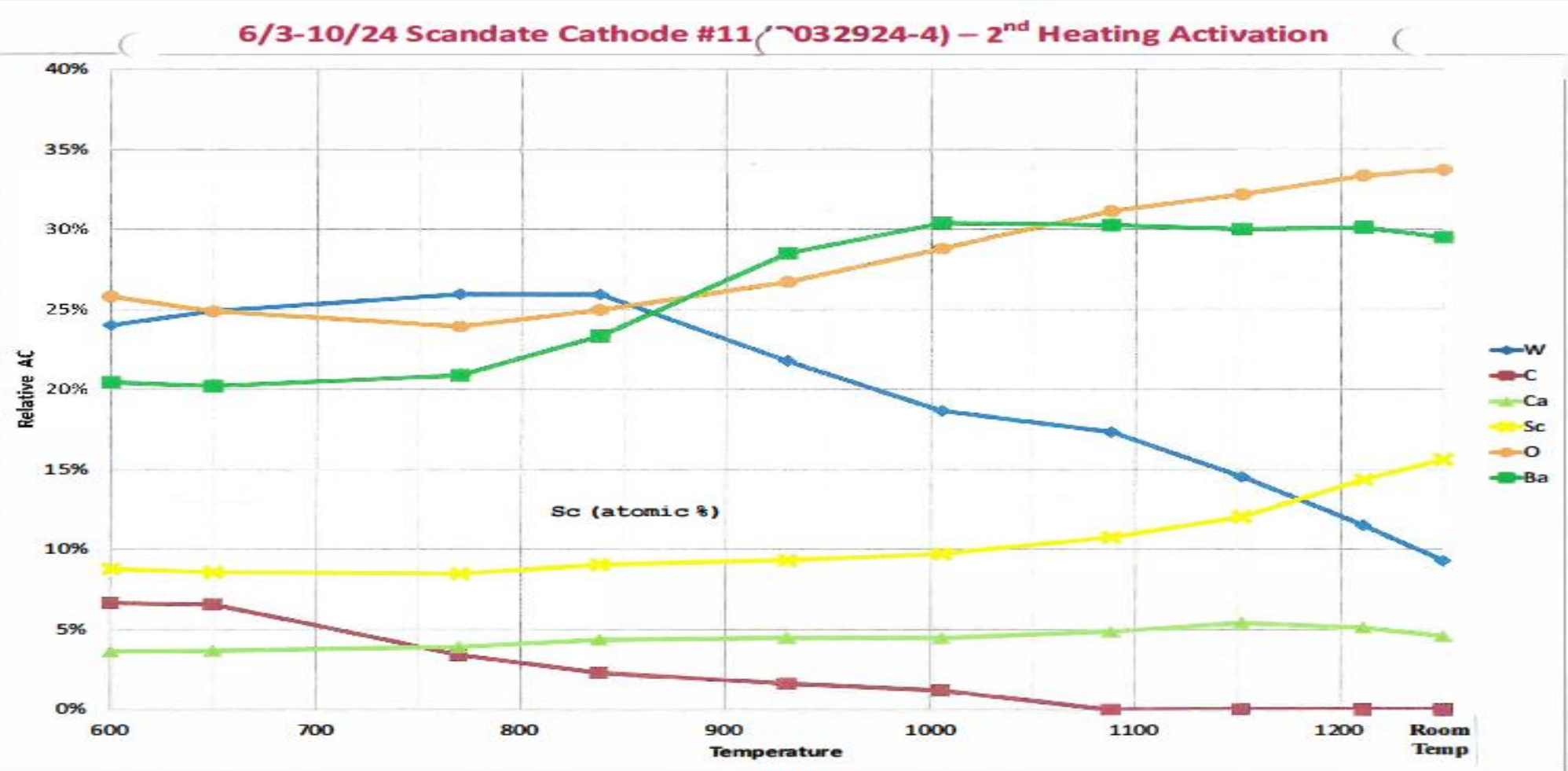
Emission in Xenon Discharge > 60 A/cm² CW



Scandate Hollow Cathode in Xenon Discharge

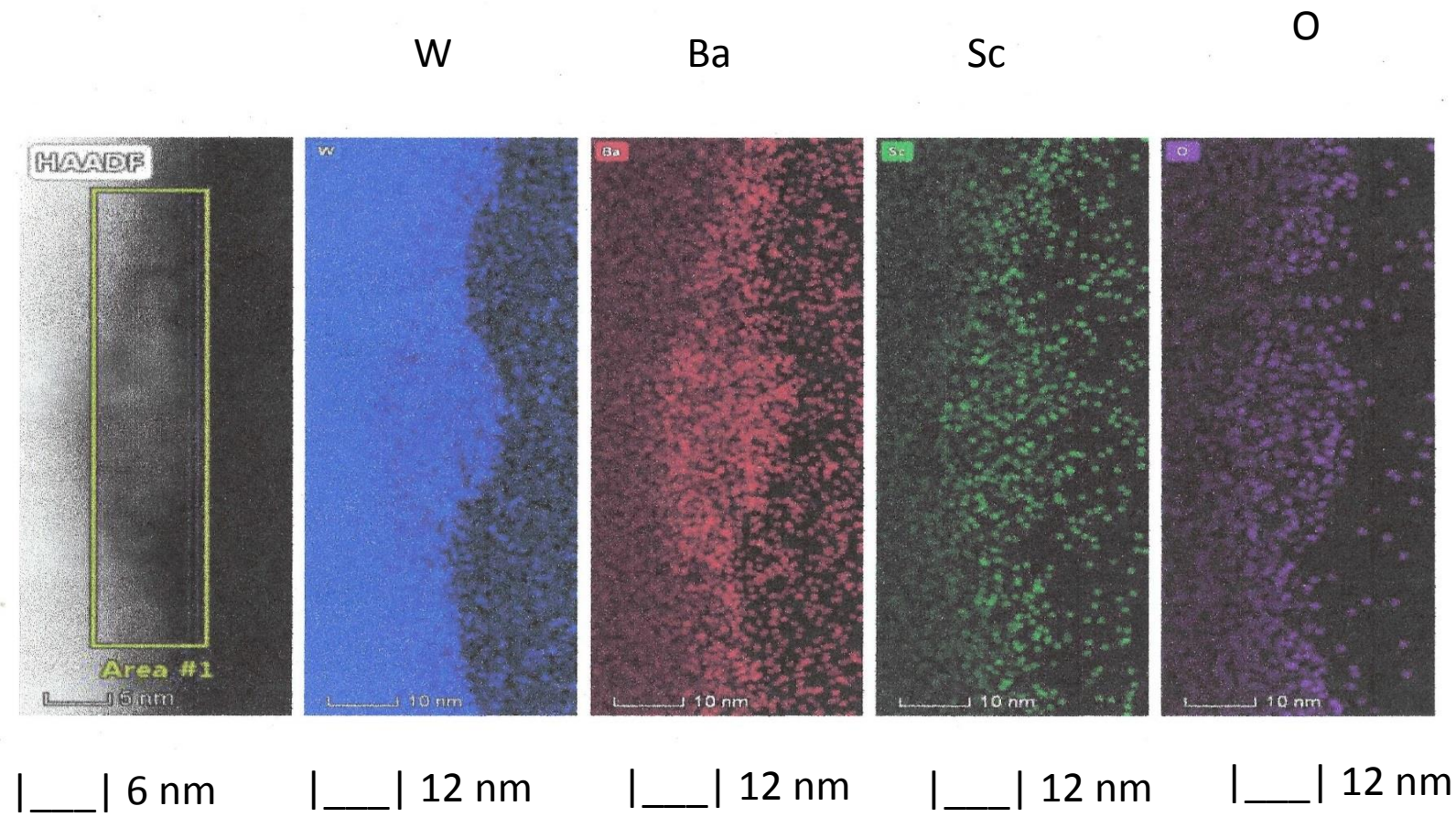


Auger Element Study in Situ Scandate Cathode vs Temp.



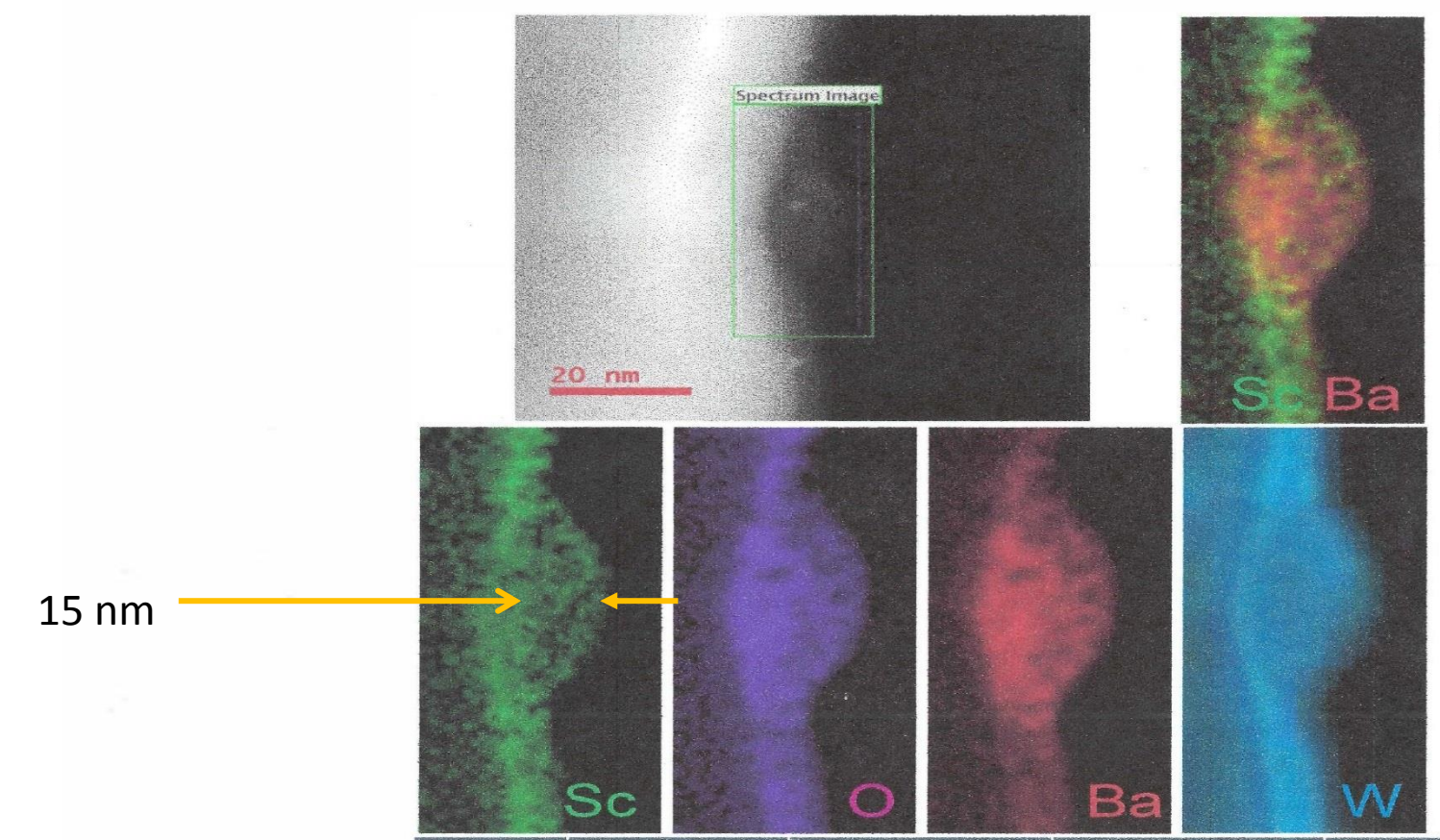
TEM Cross-section of Single Tungsten Particle

EDS With Super-X Detector



TEM Cross-section of Single Interior Tungsten Particle

Dual EELS SI



Conclusions

- Both Semi-conductor and Metal cathode behavior
- A layer of Ba-W-Sc-O appears on exterior of W particles- TEM result
- Duty Factor at 100% at >60 A/cm² for 2000 hours
- New emission model presented

References

- [1] B. Vancil, J. Balk, et al. "New Theory of Emission for Scandate Cathodes", IVEC 2026
- [2] M. Caplan, B. Vancil, et al., "Scandate Cathode Emission Theory vs. Experiment", IVEC 2026
- [3] Y. Wang, J. Wang, W. Liu, K. Zhang, and J. Li, "Development of high current density cathodes with scandia doped tungsten powders" IEEE Trans. Electron Devices, vol. 54, no. 5, pp. 1061-1070, May 2007.
- [4] Y. Wang, J. Wang, et al., "Correlation between emission behavior and surface features of scandate cathodes", IEEE Trans. Electron Devices, vol. 56, no. 5, pp. 776-785, May 2009